SMT 2018
(Standard Mortality Table 2018)

Institute of Actuaries of Japan (IAJ),
Standard Mortality Research Subcommittee

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I. Background

II. Development Process of SMT 2018
   1. SMT 2018 (For Life Insurance)
   2. SMT 2018 (For Medical Insurance)

III. Others
I. Background
1. Standard Valuation System

- Revision of “Insurance Business Act” in 1996
  ① Promotion of Deregulation and Liberalization
  ② Keeping Soundness
  ③ Ensuring Fair Business Operations

- Introduction of Standard Valuation System
  Company shall set aside a certain amount of fund as a policy reserve
  ① Method: Net Level Premium Reserve
  ② Assumptions: **Standard Mortality Table**, Standard Interest Rate
  ③ Locked-in: Assumption will be fixed at the time of contract.

- Regulations
  ① Insurance Business Act, Article 116
  ② Ministry of Finance Public Notice No.48(1996)
  **IAJ develops the SMT.**
  **FSA verifies it and revises the regulation.**
2. Procedure

IAJ reviews the appropriateness of SMT every year.

- **In Case of Revision**
  - IAJ
    1. Makes a draft
    2. Calls for comments
    3. Determines a final draft
    4. Submits to FSA
  - FSA
    1. Verifies
    2. Revises the regulation

- **In Case of No Revision**
  IAJ reports to FSA there is no need of revision, and FSA verifies it.
  IAJ announces a continuing use of current SMT for next FY.
3. History of the Experience Mortality Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1st Experience Table</strong></td>
<td>(FY 1969 - )</td>
</tr>
<tr>
<td><strong>2nd Experience Table</strong></td>
<td>(FY 1974 - )</td>
</tr>
<tr>
<td><strong>3rd Experience Table</strong></td>
<td>(FY 1981 - )</td>
</tr>
<tr>
<td><strong>4th Experience Table</strong></td>
<td>(FY 1985 - )</td>
</tr>
<tr>
<td><strong>5th Experience Table</strong></td>
<td>(FY 1990 - )</td>
</tr>
<tr>
<td><strong>SMT 1996</strong></td>
<td>(FY 1996 - )</td>
</tr>
<tr>
<td><strong>SMT 2007</strong></td>
<td>(FY 2007 - )</td>
</tr>
<tr>
<td><strong>SMT 2018</strong></td>
<td>(FY 2018 - )</td>
</tr>
</tbody>
</table>
### 4. Types of SMT

<table>
<thead>
<tr>
<th></th>
<th>FY 1996 -</th>
<th>FY 2007 -</th>
<th>FY 2018 -</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life Insurance</td>
<td>SMT 1996 (For Life Insurance)</td>
<td>SMT 2007 (For Life Insurance)</td>
<td>SMT 2018 (For Life Insurance)</td>
</tr>
<tr>
<td>Medical Insurance</td>
<td>SMT 1996 (For Medical Insurance)</td>
<td>SMT 2007 (For Medical Insurance)</td>
<td>SMT 2018 (For Medical Insurance)</td>
</tr>
<tr>
<td>After Annuitization</td>
<td>SMT 1996 (For After Annuitization)</td>
<td>SMT 2007 (For After Annuitization)</td>
<td>SMT 2018 (For After Annuitization)</td>
</tr>
</tbody>
</table>
II. Development Process of SMT 2018
1. SMT 2018 (For Life Insurance)
1. Outline of development process

- Underlying data
- Crude mortality rate
- Pre-adjustment mortality rate
- SMT 2018 (For Life)

- Modification at younger ages
- Mortality improvement

- Safety Margin (1\textsuperscript{st} Adjustment)
- Smoothing (2\textsuperscript{nd} Adjustment)
- Extrapolation (3\textsuperscript{rd} Adjustment)
2. Underlying data

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>female</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation Period</td>
<td>2008, 2009, 2011 (3 observation years)</td>
<td></td>
<td>to remove large increases in mortality rates at specific ages due to the Great East Japan Earthquake which occurred in observation year 2010</td>
</tr>
<tr>
<td>Truncated period</td>
<td>1 to 10 years (depending on gender and age)</td>
<td></td>
<td>to remove the selection effect and to ensure the prudence of the mortality rates</td>
</tr>
<tr>
<td>Policy duration</td>
<td>30 years or less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical Examination</td>
<td>Aggregate with/without examination: age 17 or younger With examination: age 18 or older</td>
<td>Aggregate with/without examination: age 27 or younger With examination: age 28 or older</td>
<td></td>
</tr>
<tr>
<td>Exposure Counts</td>
<td>40.68</td>
<td>30.02</td>
<td></td>
</tr>
<tr>
<td>(unit: million)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Claims of Death</td>
<td>263</td>
<td>95</td>
<td></td>
</tr>
<tr>
<td>(unit: thousand)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3. Mortality improvement

- From the observation periods to the implementation date
- Based on mortality improvement trends
- Using similar methodologies to the CSO in the United States

<table>
<thead>
<tr>
<th></th>
<th>For the 5 years (2010-2015)</th>
<th>For the following 3 years (2015-2018)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population mortality</td>
<td>Available</td>
<td>Not Available</td>
</tr>
<tr>
<td>experience data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data used for setting</td>
<td>MHLW's Abridged Life</td>
<td>IPSS’s Population Projections</td>
</tr>
<tr>
<td>improvement rate</td>
<td>Tables (from 2010 to 2015)</td>
<td>(January 2012)</td>
</tr>
<tr>
<td>Annual improvement</td>
<td>Male: 2.5%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Rate</td>
<td>Female: 2.0%</td>
<td>(Both male and female)</td>
</tr>
</tbody>
</table>

MHLW: the Ministry of Health, Labour and Welfare
IPSS: the National Institute of Population and Social Security Research
4. Safety Margin (1st Adjustment)

**Purpose**

- To address yearly fluctuations in future mortality
- To address differences in scale (i.e. insurance portfolio size)
- To address uncertainties in the level of future mortality

**Mathematical risk theory**

- Assuming a normal distribution

\[
\Pr \left( \frac{\bar{q} - q}{q(1-q)} \geq u(\varepsilon) \right) = \varepsilon \Rightarrow \bar{q} = q + u(\varepsilon) \sqrt{\frac{q(1-q)}{n}}
\]

- formula

\[
q_x^{(1)} = q_x^{(0)} + \min \left( 2 \sqrt{\frac{q_x^{(0)}(1-q_x^{(0)})}{n_x}}, 0.3 \cdot q_x^{(0)} \right)
\]

$q_x^{(1)}$: post-adjustment mortality rate
$q_x^{(0)}$: pre-adjustment mortality rate
$u(\varepsilon) = 2$
$n_x$: number of policies by ages
5. Smoothing (2nd Adjustment)

- it is desirable to eliminate random fluctuations and
  - To smooth the mortality curve (smoothness)
  - To maintain the characteristics of the crude mortality rate (fitness)

Method

- Greville’s formula
- Using Greville’s cubic polynomials of 13 terms

\[ q_x^{(2)} = c_0 \cdot q_x^{(1)} + \sum_{i=1}^{6} c_i \cdot (q_{x+i}^{(1)} + q_{x-i}^{(1)}) \]

\[ q_{x-i}^{(1)} = \sum_{j=1}^{6} a_j \cdot q_{x-i+j}^{(1)} \quad (x-i < 0) \]

\[ q_{x+i}^{(1)} = \sum_{j=1}^{6} a_j \cdot q_{x+i-j}^{(1)} \quad (99 < x+i) \]

<table>
<thead>
<tr>
<th>(i,j)</th>
<th>(c_i)</th>
<th>(a_j)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.240058</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.214337</td>
<td>1.016301</td>
</tr>
<tr>
<td>2</td>
<td>0.147356</td>
<td>0.360880</td>
</tr>
<tr>
<td>3</td>
<td>0.065492</td>
<td>-0.021625</td>
</tr>
<tr>
<td>4</td>
<td>0.000000</td>
<td>-0.160909</td>
</tr>
<tr>
<td>5</td>
<td>-0.027864</td>
<td>-0.138330</td>
</tr>
<tr>
<td>6</td>
<td>-0.019350</td>
<td>-0.056317</td>
</tr>
</tbody>
</table>
6. Extrapolation (3rd Adjustment)

- To estimate the mortality rates for older ages
- Gompertz-Makeham’s model

\[ \mu_x = \alpha + \beta e^{\gamma x} \]

\[ q_x = 1 - \exp \left[ - \left\{ A + \frac{B}{C} (e^C - 1) e^{C(x-x_0)} \right\} \right] \]

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>-0.0151980380</td>
<td>-0.0097866159</td>
</tr>
<tr>
<td>B</td>
<td>0.0700064560</td>
<td>0.0351813295</td>
</tr>
<tr>
<td>C</td>
<td>0.1032065545</td>
<td>0.1180349265</td>
</tr>
</tbody>
</table>
7. Comparison between SMT2018 and SMT2007 (Male)
7. Comparison between SMT2018 and SMT2007 (Female)
2. SMT 2018 (For Medical Insurance)
1. Outline of development process

Underlying data → Pre-adjustment mortality rate → SMT 2018 (For Medical)

Mortality improvement → Safety Margin
2. Underlying data and Mortality improvement

Due to the following reasons, the MHLW’s 21st Life Tables (2010) have been adopted as the underlying data:

- Increasing volume of medical insurance products offered as base policies or standalone products
- Differences in underwriting standards compared to life insurance products
- To obtain consistency with the SMT2007 (After Annuitization) which is applied to lives with the same mortality (survival) risk characteristics

The mortality rates in the MHLW’s 21st Life Tables have already been smoothed and extrapolated.

Mortality improvement is the same as that of SMT 2018 (For Life insurance)
3. Safety Margin

■ Purpose

- To address yearly fluctuations in future mortality
- To address differences in scale (i.e. insurance portfolio size)
- To address the use of population mortality data
- To address uncertainties in the level of future mortality

■ Mathematical risk theory

\[ q_x^{(1)} = q_x^{(0)} - \max \left( \min \left( 2 \sqrt{\frac{q_x^{(0)}(1-q_x^{(0)})}{n_x}}, 0.3q_x^{(0)} \right), 0.15q_x^{(0)} \right) \]

- \( q_x^{(1)} \): post-adjustment mortality rate
- \( q_x^{(0)} \): pre-adjustment mortality rate
- \( n_x \): number of policies by ages
4. Comparison between SMT2018 and SMT2007 (Male)
4. Comparison between SMT2018 and SMT2007 (female)
III. Others

IAJ is preparing the details of the development process of SMT 2018. You will be able to get it on the website of the IAJ in mid-October.

http://www.actuaries.jp/english/index.html

You can find the development process of SMT 2007 on the website.

http://www.actuaries.org/CTTEES_TFM/Documents/MWG_Zurich_Item13_SMT_Japan_Yamazaki.pdf
Thank you for your attention!

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